PROGRESSIVE IMAGE/VIDEO RETRIEVAL FROM A SCALEABLE ARCHIVE

http://maya.ctr.columbia.edu:8080

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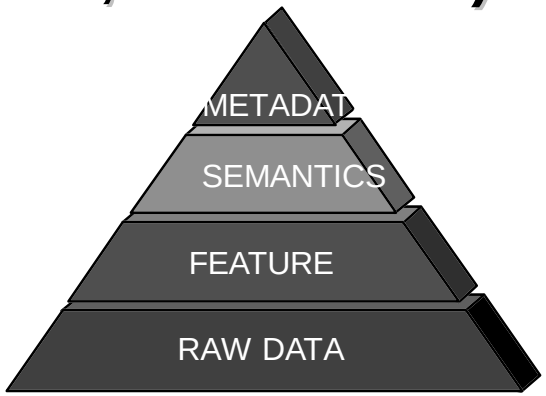
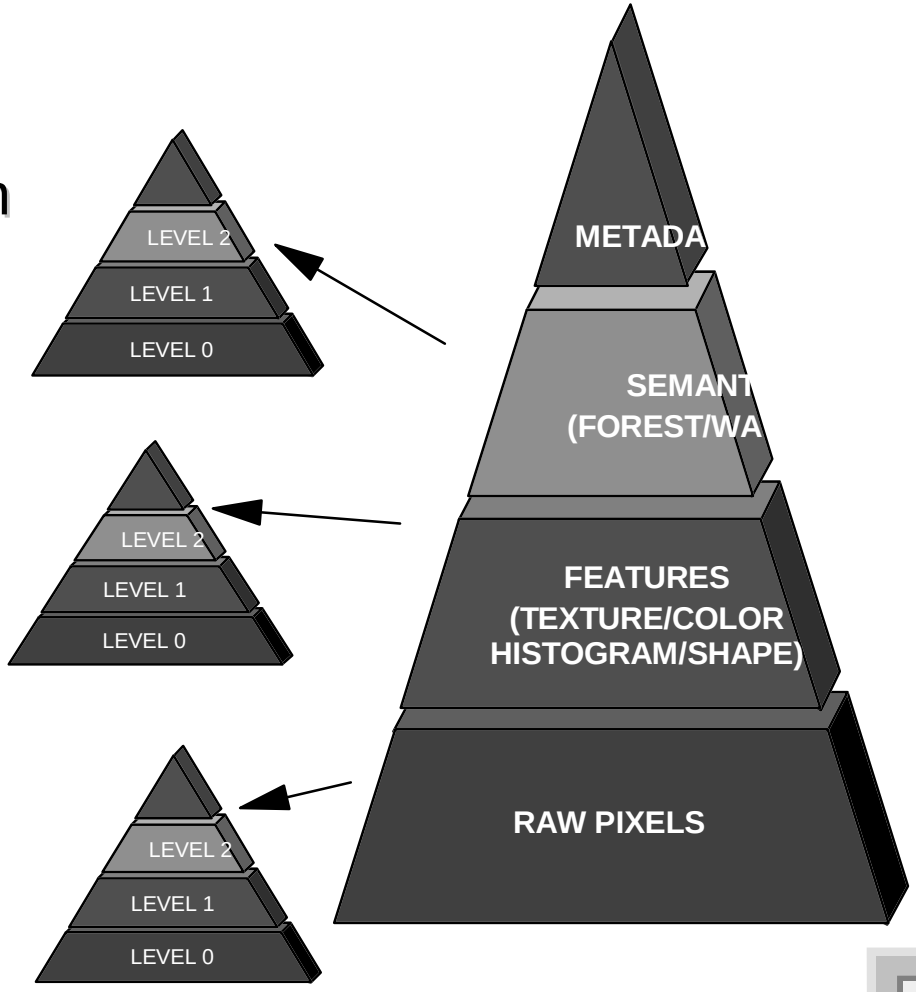
PROJECT OVERVIEW

- $4M jointly funded by NASA/IBM (1995-1997)
- Team
  - 7 in Yorktown (5 RSMs, 1 software engineer, 1 contractor)
  - 6 in Boulder
- Focus
  - Scalable content-based retrieval
    - progressive data representation (TB~PB)
    - progressive search
  - Fast prototyping query environment
  - Interactive image navigation
- User evaluation
  - U.S. Forest Service (INFER: G7 showcase)



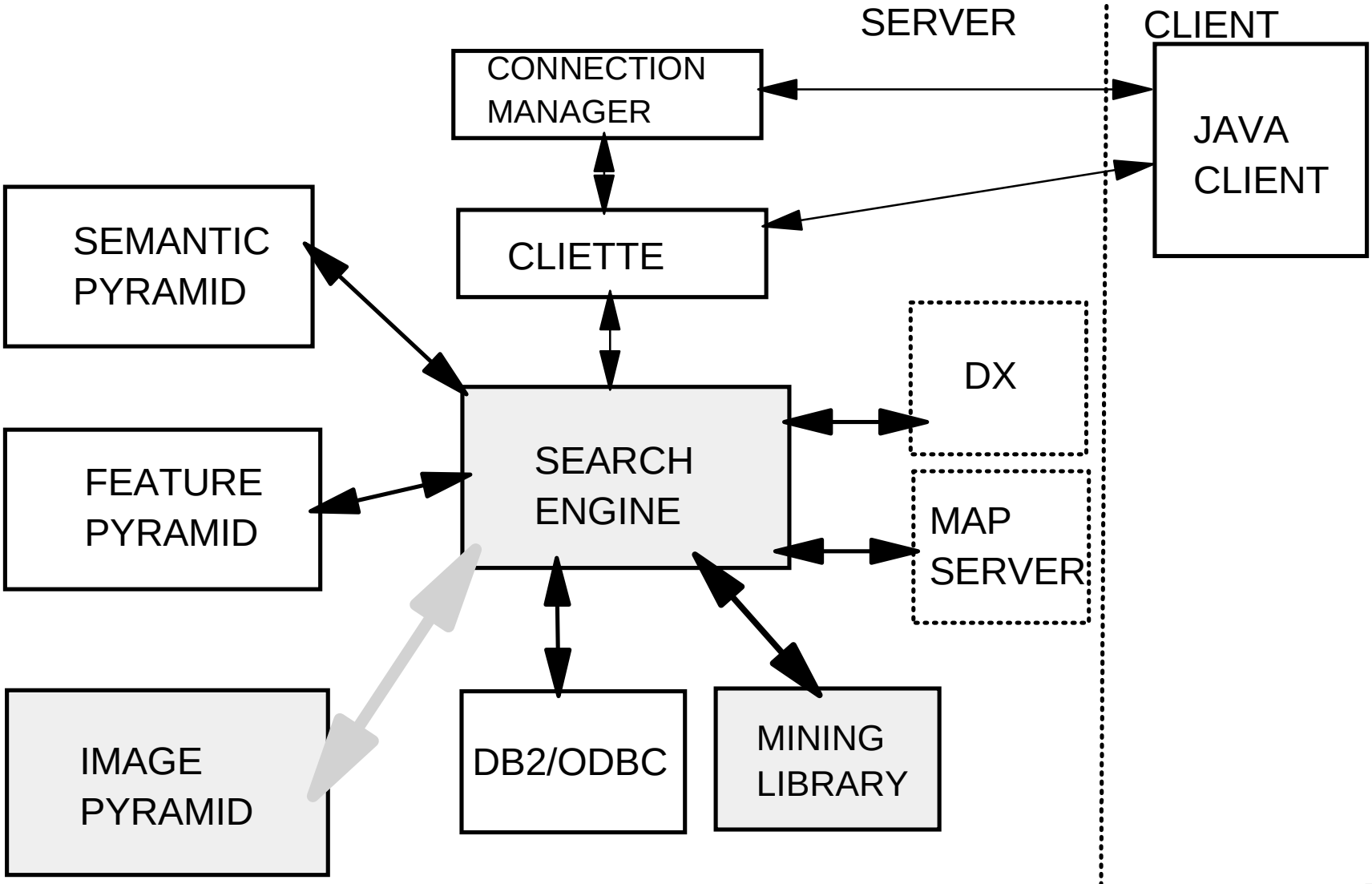
PROGRESSIVE FRAMEWORK

- Data representation
  - dichotomy between data and metadata --> continuum
  - multiple abstraction levels (metadata, semantics, feature, raw pixel)
  - multiple granularity (Flashpix like)
- Search engine
  - progressive feature extraction
  - progressive classification
  - progressive search

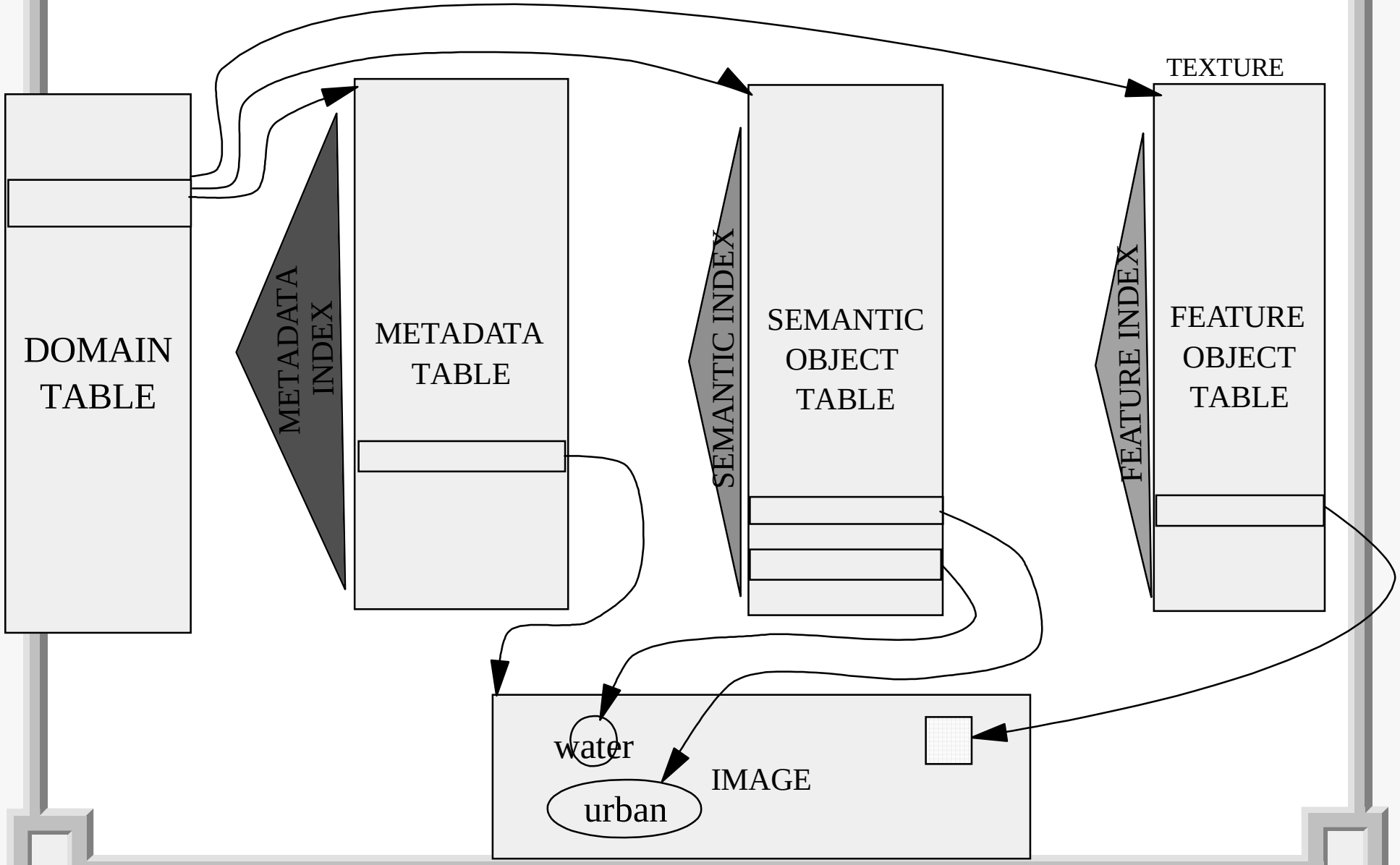


SAMPLE IMAGE FROM SPACE IMAGING

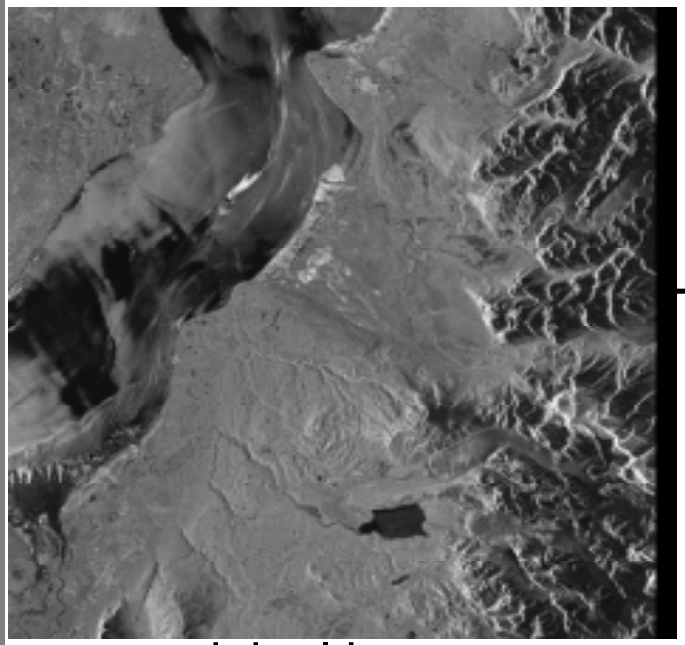
SYSTEM ARCHITECTURE



SCHEMA

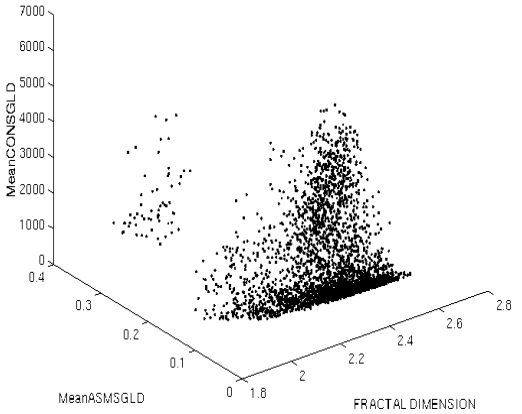

DOMAIN TABLE
METADATA INDEX
METADATA TABLE
SEMANTIC INDEX
SEMANTIC OBJECT TABLE
FEATURE INDEX
TEXTURE
FEATURE OBJECT TABLE
water
urban
IMAGE

GENERATION OF MULTIPLE ABSTRACTION LEVELS



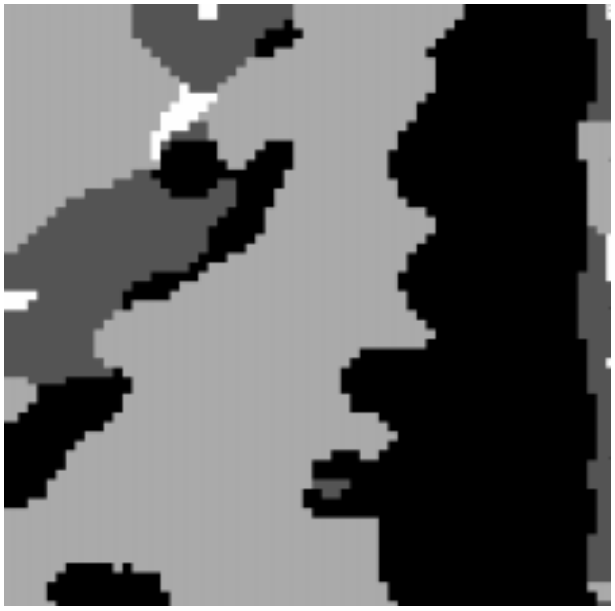
original image

FEATURE EXTRACTION



Feature space

CLUSTERING

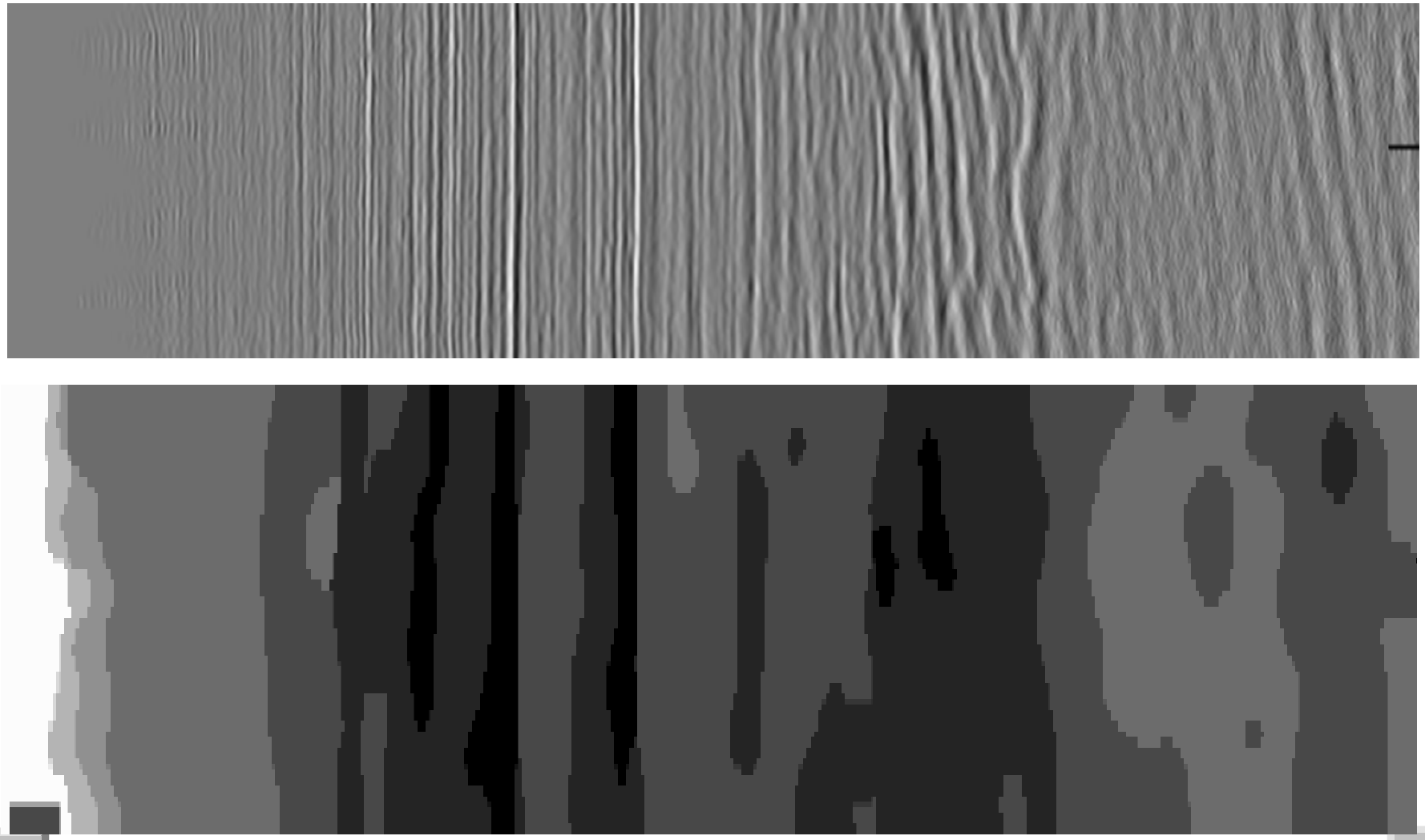


segmented image

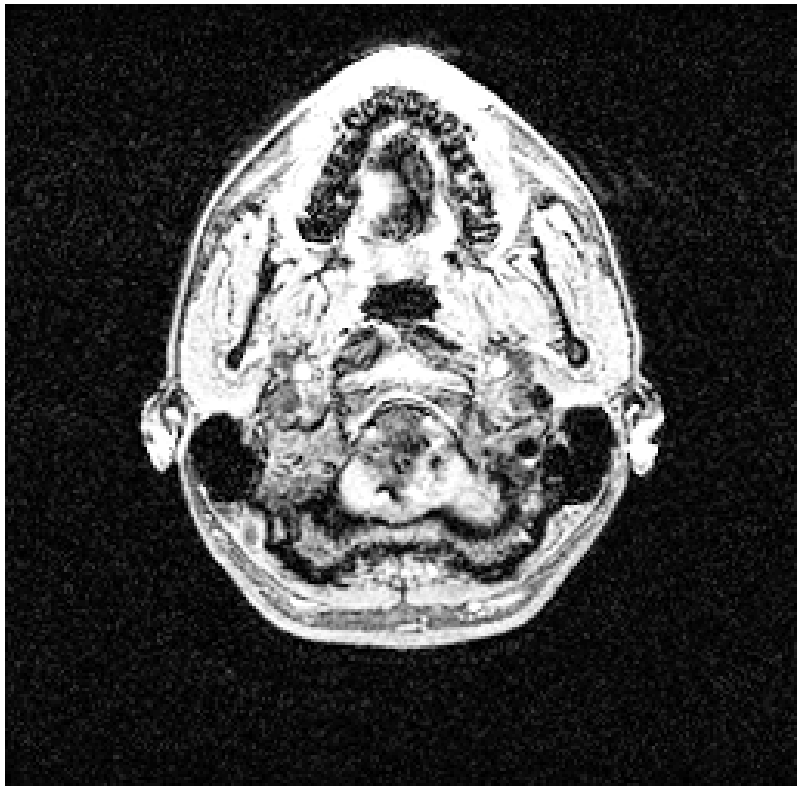
SEMANTIC EXTRACTION

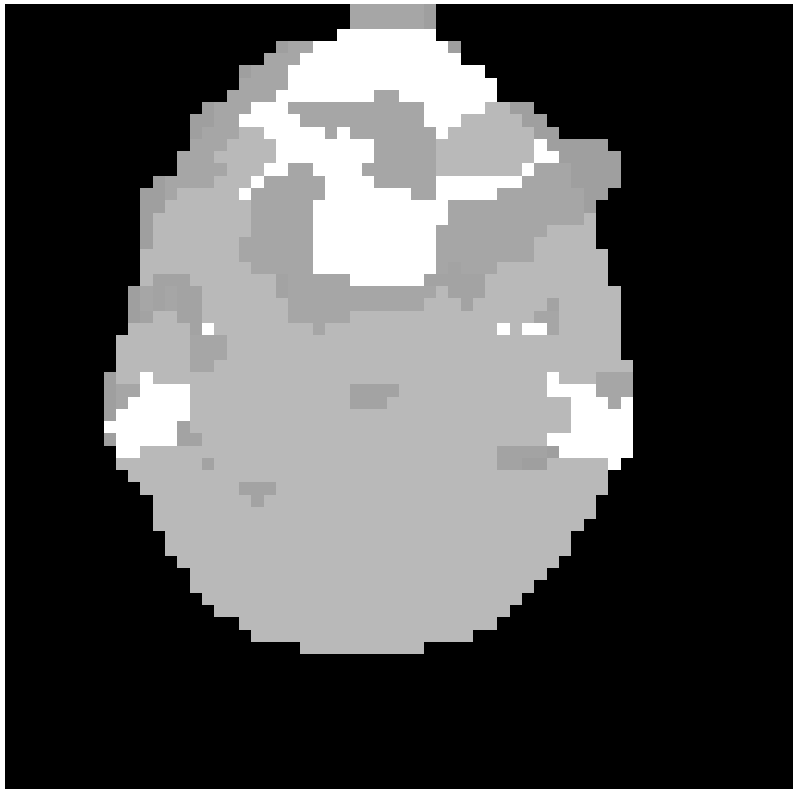
(x1,y1,x2,y2) terrain
(x3,y3,x4,y4) thin ice
(x5,y5,x6,y6) thick ice
(x7,y7,x8,y8) thin ice
.....

SEGMENTATION OF SEISMIC DATA

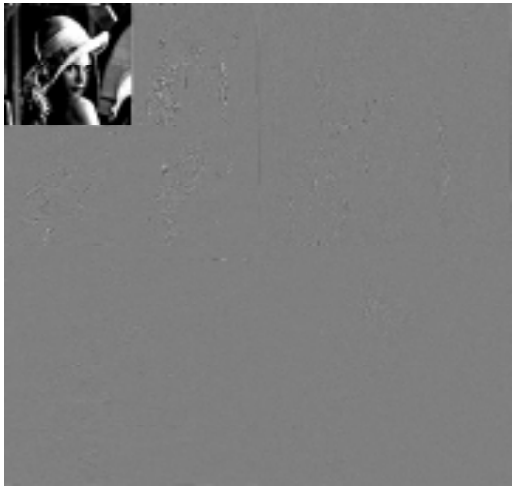


SEGMENTATION OF MRI IMAGES

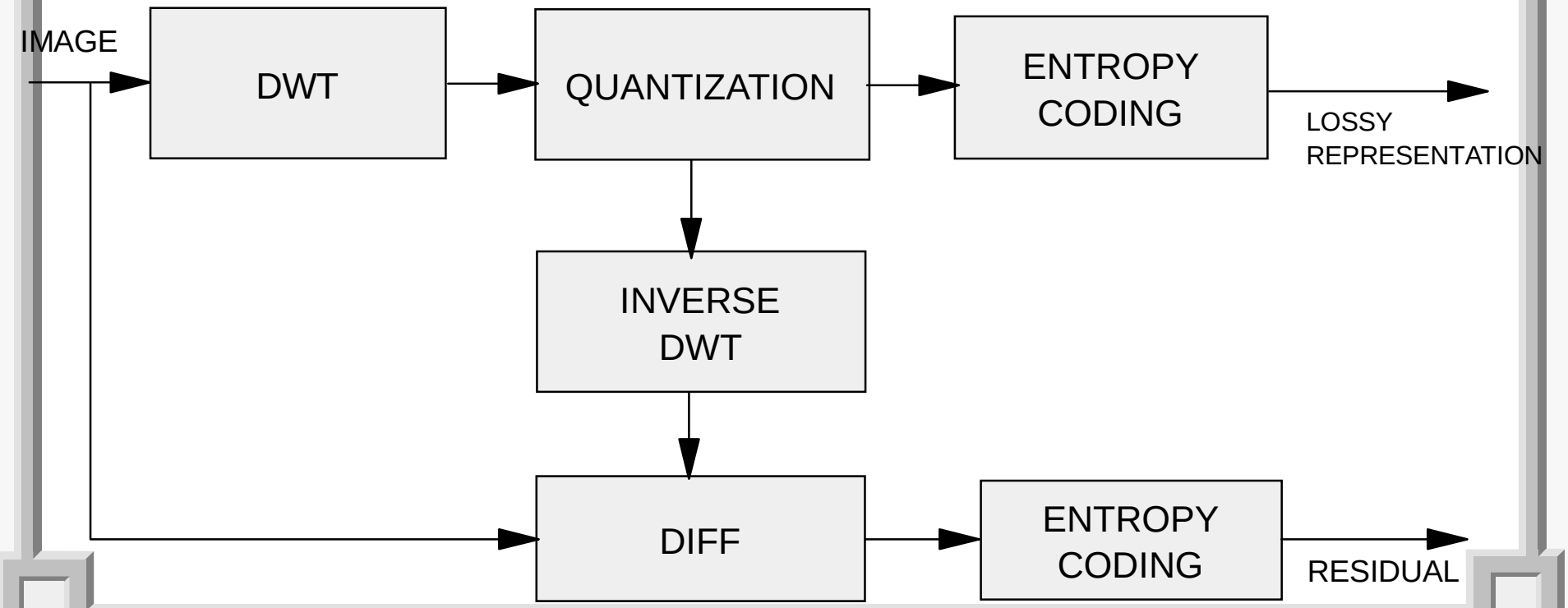




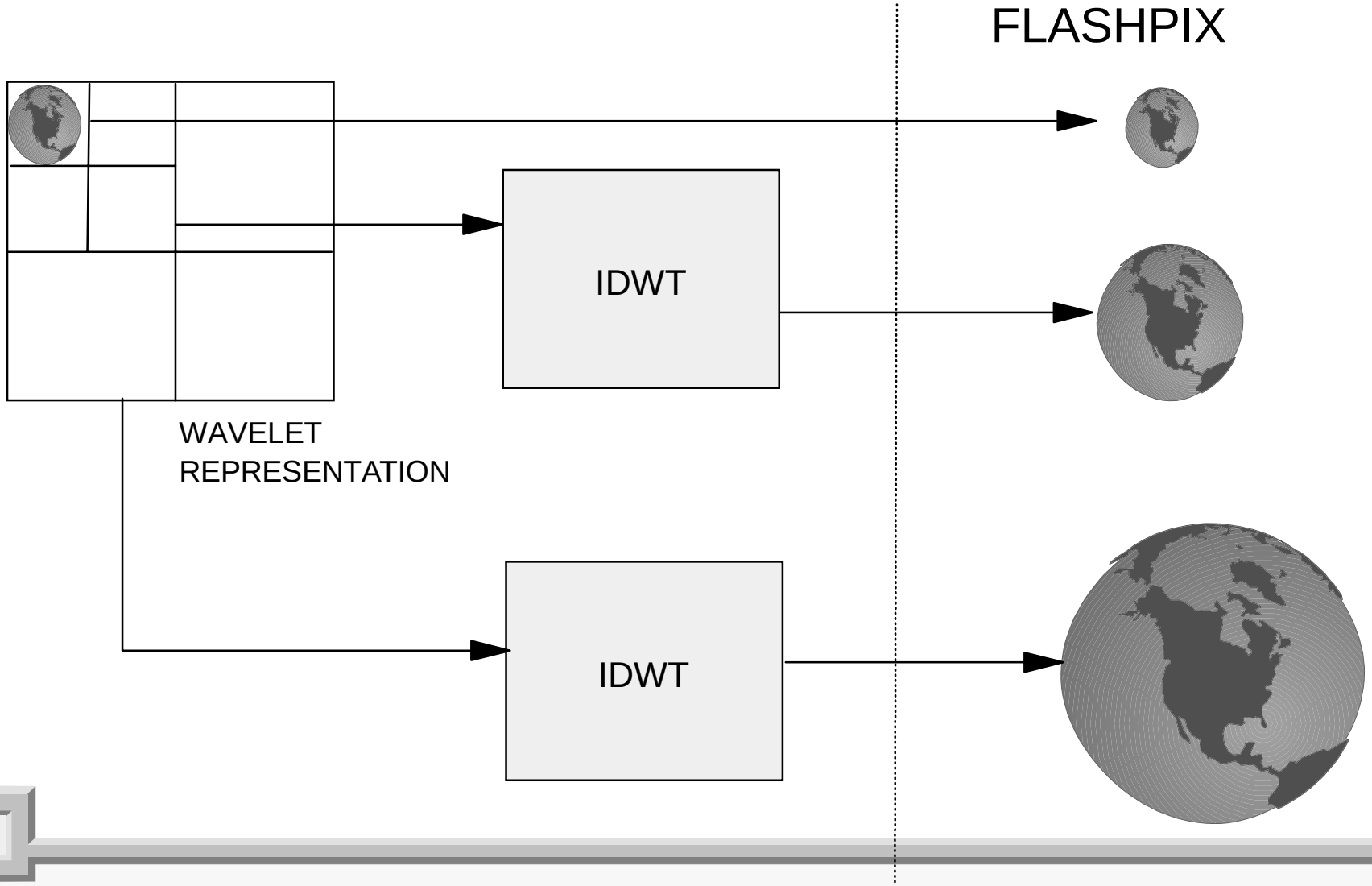
Progressive Data Representation



- Lossy/Lossless compression
- Flashpix compatible
- Efficient region subsetting enabled by tiling

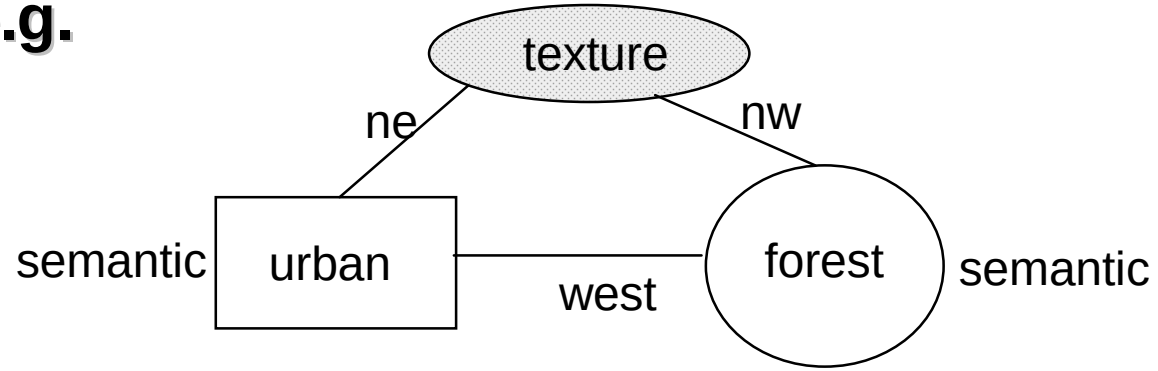


Synthesis of Multiple Representations

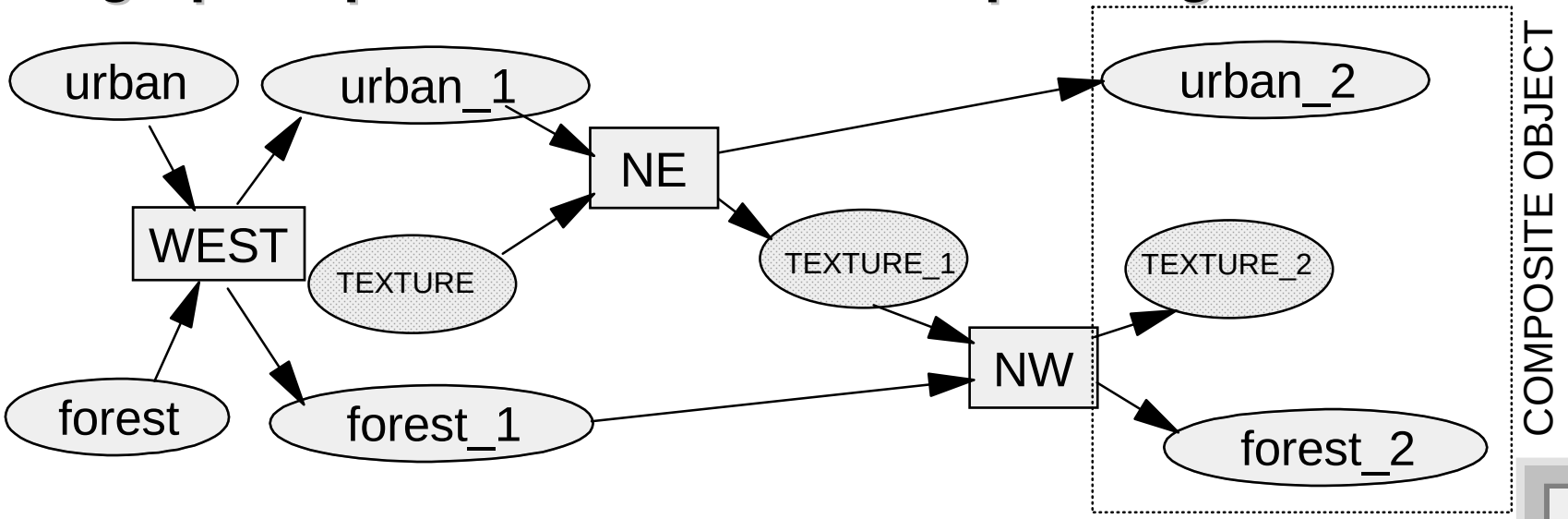


PROGRESSIVE SEARCH ENGINE

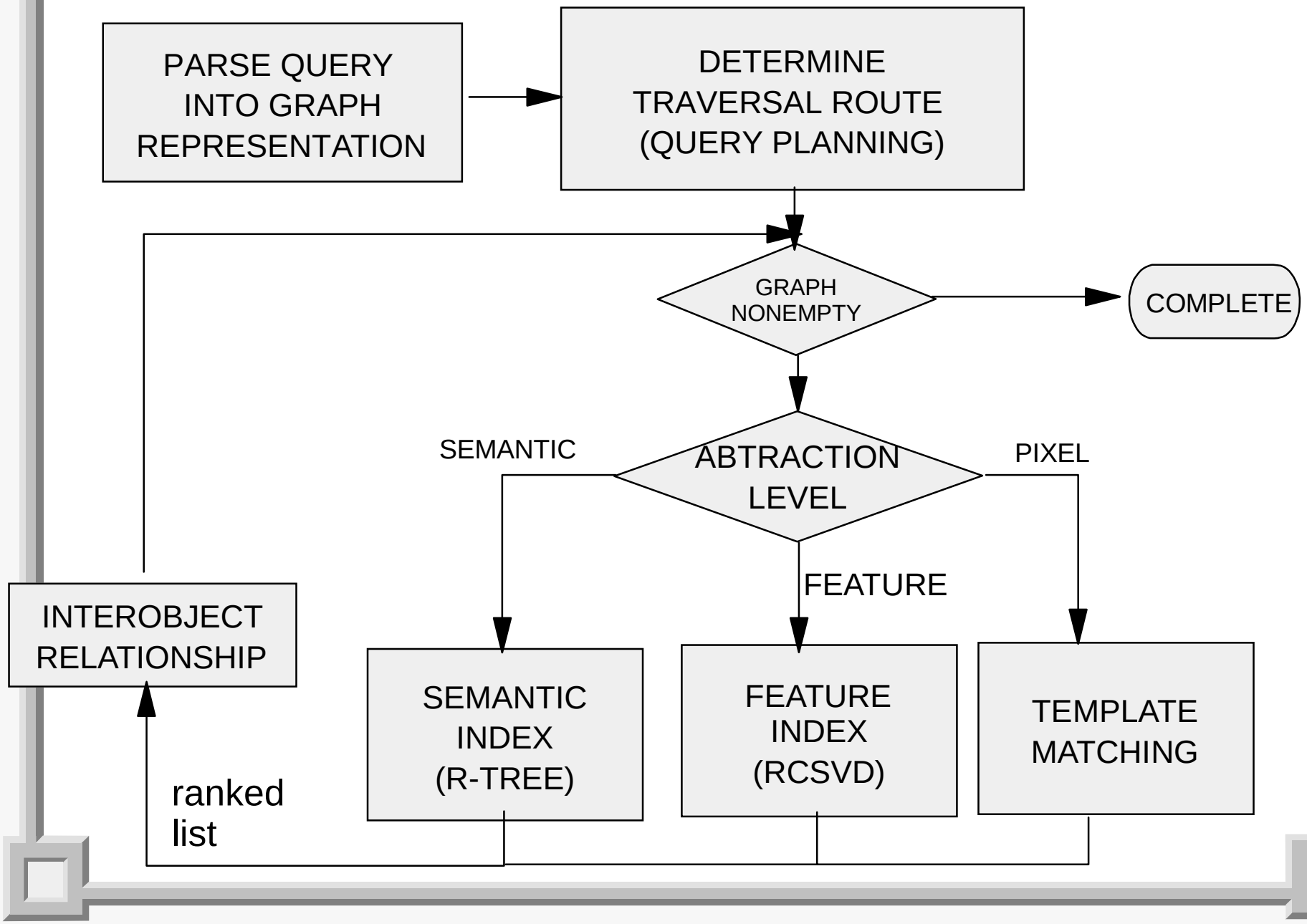
- **Composite objects defined at semantic, feature, pixel level, e.g.**



- **The graph is parsed into a minium spanning tree**

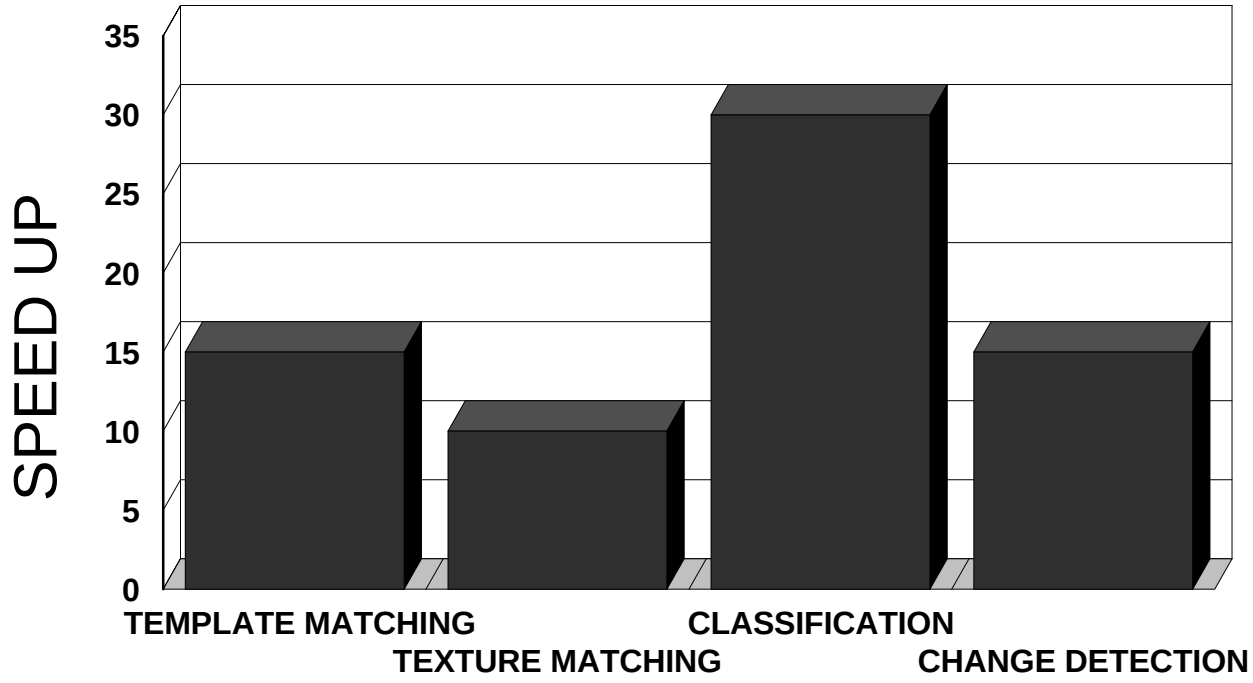


IMPLEMENTATION OF SEARCH ENGINE



SEARCH PERFORMANCE IMPROVEMENT

- **Progressive search**
  - **Start at the appropriate resolution level for data (raw data or feature data) with multi-granular representation**
  - **Only those promising areas will be searched at an improved resolution level**



Interactive Multimedia Query Environment

- **Extensible environment for constructing and querying multimedia "objects"**
  - **user-defined features**
  - **user-defined objects based on features or semantics**
  - **composite object consisting of multiple atomic objects with spatial/temporal/boolean relationships**
  - **fuzzy relationships**
- **Fast prototyping environment: synthesize query environment for new solutions/applications**
  - **BNF specifications**
  - **layout specification**
  - **context-dependent rules**

Interactive Image Navigation

- Image navigation
  - location [(latitude, longitude or (x,y)]
  - time,
  - modality (instrument)
  - low-level feature (texture/spectral histogram)
  - high-level semantics (forest, urban area)
- Image visualization
  - map overlay
  - 2D-3D perspective views
  - digital elevation models
  - color, contrast

BENEFITS

- Complements VI
  - Progressive storage management
  - Progressive search on data and metadata
  - Rich image/video mining tools
- Complements QBIC/Iris
  - Multi-modal/Multi-granularity search
  - User defined features/objects
  - search for localized objects within an image
- Enhance DB2 extenders
  - spatial extenders
  - multimedia extenders